

Intelligent Power Stages (IPS)

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Project Status: Ongoing **Project Term:** 2020.07~2023.09 **Award Amount:** **Partners:** ORNL

Project Summary

An intelligent power stage (IPS) with advanced features including active gate driver with prognosis and diagnosis function is developed and demonstrated, aimed to improve the robustness and reliability of grid-tied converters interfacing renewable energy source and energy storage elements. The prototype is a 3-phase interleaved DC/DC stage with a 500V-1kV DC input, and a 3-phase DC/AC stage rated at 50 kW and 480 Vac. The proposed advanced features are verified on the developed IPS hardware.

Technical Approach

- ✓ An integrated intelligent gate driver (i2GD) with active gate driver (AGD) and health monitoring (Prognosis & Diagnosis, P&D) functions.
- ✓ Enhanced EMI-immune IPS control with high A/D sampling CM noise rejection.
- ✓ All optical fiber-based bidirectional communication among SUPER, IPS controller, and gate driver with speed up to 50Mbps.
- ✓ Low-latency hardware-based LVRT control to suppress inrush current during transients.
- ✓ Self-sustained Auxiliary Power Supply (APS) fed from dc or ac bus.

Accomplishments

- ✓ Two 50kW IPS prototypes built and tested at 50kW in closed-loop mode.
- ✓ One IPS prototype has been fabricated with cabinet and delivered to ORNL.
- ✓ Advanced features of AGD and P&D functions has been verified experimentally.
- ✓ Grid-tied closed-loop experiments have been tested successfully.
- ✓ The enhanced EMI-immune control and high-speed all fiber optic-based communication between SUPER, IPS local controller, and gate drivers have been implemented and validated.
- ✓ Start-up and shut-down experiments for both standalone and grid-tied modes have been tested successfully.
- ✓ Two SUPER controllers have been built and tested.
- ✓ Five conference papers published on ECCE, APEC, WIPDA and ITEC.

Impact/Commercialization

- Provide a general solution to improve reliability and resilient grid integration of renewable energy with storage.
- Apply not only to next generation WBG device-based grid-tied power electronics but to traditional grid-tied power electronics as well.
- Enable the revolutionary approach to integrate renewable energy based on SUPER+IPS.

Future Work

- Improve active gate driver and its prognosis functions.
- Apply the proposed intelligent gate drive approach to medium-voltage IPS.

